Next Generation Imaging Payloads

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INTRODUCTION

At Lockheed Martin Missiles & Space, we have been pursuing a program to develop large aperture payloads for future missions. The program roadmaps will show how the transition from present programs (SIM and NGST) through the near team programs (DS-3) will result in systems featuring 20 to 40 meter class telescopes. The technologies developed and yet to be developed will be discussed. Then, the trade space will demonstrate what can be done with filled apertures and sparse apertures. Our MultiAp concept designs will be presented as a possible solution to the problem.

ROADMAP

Our present task is to design a system called SIM (Space Interferometer Mission) as the industry partner (along with TRW) of JPL. This is an interferometer on an 11 to 13 meter baseline. The future steps would be DS-3, which are interferometers on separated spacecraft and the Next Generation Space Telescope (NGST). Further out in time, we are thinking of Planet Finder, Earth Resources MultiAp, and the New Millennium Interferometer.

Our objective is to provide critical technology capabilities to substantially increase the resolution while reducing the cost of future space based imaging systems for both astronomical and earth resources applications.

TECHNOLOGIES

Technologies necessary to provide all imaging payloads include but are not limited to: telescope phasing, LOS control, image stabilization, lightweight structures and optics, fast steering mirrors, deployment mechanisms, isolation and dampening, focal planes, active control loops, and precision alignment. Unique technologies include: scene independent phasing sensor, pupil mapping control, long baseline precision metrology, interference fringe tracking, low temperature components, phasing sensors for long integration times, and nulling interferometers.

The technology roadmap must be shown that will achieve the goals of the mission roadmap. One such achievement in technology has been the successful test bed called the MultiAp Demonstrator.

TRADE SPACE

The trade space available to this technology offers the first choice between filled or sparse apertures. The sparse aperture approach, in its linear form, is the solution to the SIM program and is probably the only way to project technology to very large apertures by using the 2D form. There are advantages and disadvantages to both approaches. Weight and cost are the main advantages of a sparse aperture but its performance can not match the ability of the filled aperture. However, I will now concentrate on filled apertures, giving the detailed trade space for a NGST mission. The filled aperture approach can be separated into Segmented Primary, Multiple Telescope Array, Monolith and Inflatable. The monolith is limited by the size of the launch vehicle shroud and the inflatable, although it possesses great potential, has the drawbacks of immature technology and high risk. The segmented aperture will most likely be the NGST solution and is again limited to the size of the launch vehicle shroud, although we have a solution to fold a eight meter telescope which is more capable then the largest monolith (six meters). An alternate solution to the NGST trade space is the multiple telescope array. However, we have ruled out this specific solution for the final NGST consideration. The principle reason for its inclusion here, is its ability to trace to the future and match the requirements of this conference. The challenge of this conference is accepted and I will show only the NGST trades but continue to labor in the field of expanding its trade space to the 20 to 40 meter regime.

MULTIPLE TELESCOPE ARRAY

An array of multiple telescopes can be designed to perform as a filled aperture telescope of six or eight elements. The array then has independent telescopes, which have the immediate advantage of a shorter secondary mirror tower and can be much more compact. This will allow further packaging studies only limited by the size of the shroud. The telescopes have re-imaging delay lines and a common beam combiner to yield its designed performance. The maximum size we have been able to package is an eight telescope array nearly filling the eight meter requirement (about 75%) which is less than the segmented primary approach.

If we propose a sparse array of individual telescopes, the effective aperture can be increased to much larger sizes. We have designs covering the available launch vehicles with up to am aperture of 25 meters. With the intended future improvements to the shroud sizes, we can predict ability to create a 40-meter design.